

The effectiveness of POST-DISCHARGE telerehabilitation practices in COVID-19 patients: Tele-COVID study-randomized controlled trial

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Abstract:

AIMS: We aimed to investigate the effectiveness of a telerehabilitation exercise program performed without requiring any special equipment on the physical condition of COVID-19 subjects.

SETTINGS AND DESIGN: This was a randomized controlled study.

METHODS: This study included subjects with a history of hospitalization with a diagnosis of COVID-19 and discharged within 4 weeks. The subjects were divided into two groups randomly, namely telerehabilitation group (TeleGr, $n = 17$) or control group (CGr, $n = 17$). The TeleGr received breathing and range of motion exercises, active cycle of breathing technique, and an aerobic training 3 days a week for 6 weeks, while CGr received an exercise brochure with the same content. Subjects were evaluated using the modified Medical Research Council (mMRC) dyspnea score for dyspnea, 30 s sit-to-stand test (30STS) and short physical performance battery (SPPB) to determine their physical status, Saint George Respiratory Questionnaire (SGRQ) to assess quality of their life, and Beck Depression Inventory. All evaluations were carried out at home using videoconferencing.

RESULTS: A significant improvement was observed in TelerGr in terms of mMRC ($P = 0.035$), 30STS ($P = 0.005$), 5 sit-to-stand time which is one of the subtests of SPPB ($P = 0.039$) and SGRQ scores. Significant improvement was observed only in the pain score in the CGr ($P = 0.039$). There was a statistically significant difference between the groups in SGRQ activity ($P = 0.035$) and total ($P = 0.042$) scores. In addition, more symptomatic improvement was found in TeleGr.

CONCLUSION: Telerehabilitation exercise program with less technical equipment is a good alternative treatment method for COVID-19 subjects, which improves the quality of life and symptomatic status of subjects.

CLINICAL TRIAL REGISTRATION NUMBER: nct04402983

Keywords:

Depression, exercise, pandemic, physiotherapy, quality of life, rehabilitation

Approximately 81% of subjects with confirmed COVID-19 infection develop mild-to-moderate disease without viral pneumonia, while severe disease occurs in 14% of viral pneumonia cases.^[1] Dyspnea, tachypnea, and desaturation may occur in

individuals with severe COVID-19 infection. Acute respiratory distress syndrome, septic shock, and/or multi-organ dysfunction may develop in 5% of cases.^[1,2] On average, 5% of cases should be monitored in the intensive care unit.^[2] The disease affects the heart, circulatory system, blood parameters, muscles, and neurological system, as well as the respiratory system.^[3]

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Following acute viral infections such as H1N1 and severe acute respiratory syndrome, it has been shown that there remain some respiratory, physical, cognitive,^[4,5] and emotional dysfunctions^[6,7] which affect subjects' quality of life negatively.^[8] The greatest improvement in physical function after a diagnosis of acute respiratory failure occurs in the first 2 months after discharge.^[7] In cases with comorbidities, the process may be prolonged a little.^[5] Physiotherapy is an important treatment modality in regaining the mentioned physical function losses.

COVID-19 disease is transmitted in a short time by droplet and contact. Physiotherapists are generally in close contact with subjects and may be directly exposed to the respiratory droplets of subjects. Considering these drawbacks, it is not always possible for patients to receive physiotherapy interventions. In addition, some symptoms (such as fatigue and exercise intolerance) continue to be seen in patients in the postacute and chronic period and physiotherapy is a need in this direction. This situation raises the use of alternative methods to standard physiotherapy applications.

Telerehabilitation is a rehabilitation method used, especially for patients who have problems with transportation to the hospital. When the telerehabilitation studies are examined, it is noteworthy that pre- and postprogram evaluations are carried out in the hospital, the exercises are performed synchronously with the videoconference method or exercise videos are used.^[9,10] In our literature review, we did not find any study in which evaluations were carried out in the home environment and no special technical equipment was used.

In our study, we aimed to investigate the feasibility and effectiveness of a telerehabilitation exercise program performed without requiring any special equipment and low cost, and to provide social benefit by improving the symptoms and sequelae of the disease.

Methods

This study was a prospective, single-center, randomized, and controlled trial with concealed allocation. It was carried out under the supervision of the local ethics committee (Protocol Number: 20/36, Date: May, 09, 2020) and registered in the ClinicalTrial.gov website (Registration Number: NCT). It was conducted in accordance with the Helsinki Declaration. Written informed consent was obtained from all participant subjects.

The cases who applied to X Chest Diseases and Thoracic Surgery Training and Research Hospital with COVID-19 symptoms and were admitted to the chest services and discharged were evaluated. Subjects aged 18–75 years,

diagnosed with COVID-19 and discharged after treatment, still in the first 4 weeks after discharging, described by regression in physical functions after discharge compared to preillness, and had access to technological facilities integrated with smartphone were eligible for inclusion in the study. Those with any comorbidity that could prevent exercising, subjects with neurological and cardiac deficits, and did not agree to be participate in the study were excluded.

Participants who met the study inclusion criteria and completed the baseline assessments were randomly allocated into one of the two groups: telerehabilitation Group (TeleGr) or control Group (CGr), using a numbered series of 34 prefilled envelopes specifying group assignment generated by a computer-based program. The subjects and the physiotherapists were blind. The evaluations were made by the physiotherapist in the synchronized live videoconference method using smartphone. The exercises were also performed by the physiotherapist with a live videoconversation. The brochure was sent to the CGr as a phone message. All subjects were under follow-up by a pulmonologist and received their optimal medication.

TeleGr underwent an exercise program 3 days a week for 6 weeks. The program included patient education, paced running/self-walking on the corridor, breathing exercises, active cycle of breathing technique, range of motion exercise, and standing squat. The exercises were done 10 times per session. The number of repetitions was modified according to the fatigue rate. Considering the fatigue and patient tolerance, the intensity of the exercise was done at a medium intensity (11–12 scores) by questioning the perceived effort Borg scale to the subjects. In all exercises, the patients were asked to place the camera in a place, where the patient could be easily seen by the physiotherapist. The exercises were carried out under the commands of the physiotherapist. Despite the possibility of any problem (such as the risk of falling), the subject's relative was requested to be in the room during the exercise sessions. Exercise was interrupted in case of excessive fatigue, palpitations, dyspnea, and the subjects's request to interrupt exercise.

The CGr received one session of exercise training and a brochure including similar exercises as the TeleGr by smartphone. The brochure included patient education, breathing exercises, range of motion exercises, self-walking, and squats on the wall. Participants were asked to do their exercises 3 days a week for 6 weeks. If a problem was felt during the exercises (such as extreme tiredness, palpitations, and dyspnea), it was recommended to stop the exercise.

Outcome measurements

The evaluations of the participants were carried

out online due to the pandemic conditions by live videoconferencing. Therefore, evaluations were selected from tests that are suitable for online evaluation.

Modified Medical Research Council dyspnea score

The modified Medical Research Council Dyspnea Scale is best used to establish baseline functional impairment due to dyspnea attributable to respiratory disease. The severity of dyspnea is rated on a scale of 0–4. “0” means no dyspnea perception and “4” means severe dyspnea perception.^[11]

Symptomatic status

The pain and fatigue levels of the cases were evaluated using visual analog scale score. The scale presented as a 10 cm horizontal ruler is a documented method for scoring continuous soft data. “0” score means no pain and “10” means very severe pain.^[12]

The Timed Up and Go Test

The Timed “Up and Go” (TUG) test measures in seconds, the time taken by an individual to stand up from a standard armchair walk a distance of 3 m, turn, walk back to the chair, and sit down.^[13] During the test, the subject was asked to place the camera in a place that chair could be seen in the 3-m area, and the commands were given by the practitioner over the phone.

The short physical performance battery

The short physical performance battery (SPPB) is comprised three tasks: a standing balance test (side by side, semi-tandem, and tandem), a 4-m habitual gait speed, and 5 sit to stand from a chair. Each task is scored (based on time) from 0 to 4 points. The total score is 12 points and this represents the highest performance.^[14] During the test, the subject was asked to place the camera in a place where the test will be performed, and the commands were given by the practitioner over the phone.

Saint George Respiratory Questionnaire

It is a disease-specific instrument designed to measure impact on overall health, daily life, and perceived well-being in subjects with airways disease. Its score ranges from 0 (no impairment of quality of life) to 100 (highest impairment of quality of life).^[15] The questionnaire questions were asked to the subjects one by one via smartphone and were noted by the practitioner.

Beck Depression Inventory

The Beck Depression Inventory (BDI) is a 21-item, self-report rating inventory that measures characteristic attitudes and symptoms of depression. Increasing score means depression is violent.^[16] The questionnaire questions were asked to the subjects one by one via smartphone and were noted by the practitioner.

Statistical analysis

Statistical analysis was conducted using SPSS version 25 (SPSS Inc., Chicago, IL, USA) package program. The Shapiro–Wilk statistic was used to test the normality of the distribution of all variables. Nonparametric tests were used in comparison. The Wilcoxon signed-rank test was used to compare the pre- and posttreatment data of the groups, and the Mann–Whitney *U*-test was used in the group-wise comparison. Nonparametric variables were expressed as median (minimum–maximum), and descriptive variables as percent. The Chi-square test was used for categorical variables. The significance level was accepted as $P < 0.05$ in all tests.

The study sample size and power analysis were carried out using “Power and Sample Size” software. We estimated the sample size of 15 subjects for each group to have 95% power (level 20%) and 0.05 significance level (α level 0.05) to detect a minimum clinically significant differences.^[17] Considering the dropout subjects, 17 subjects were included in this study.

Results

Among 61 people who were invited, 40 participants completed the rehabilitation program (65% response rate). A total of 6 cases were dropped out for different reasons. The reasons for dropout are summarized in Table 1 and study flowchart is given in Figure 1. Thirty-four subjects who completed the program were examined. Among 34 respondents, 73.5% ($n = 25$) were males and the mean age was 47 years (standard deviation 14).

Demographic features, hospital admission symptoms, and dropout reasons are presented in Table 1. There were no significant differences in demographic characteristics between the two groups ($P > 0.05$).

When the baseline characteristics of the groups were compared, it was observed that in their symptomatic states, except for the excess of secretion retention in TeleGr ($P = 0.041$), they had similar symptoms. The TUG and SPPB scores which were used in determine their physical performance and BDI scores were similar ($P > 0.05$). In Saint George Respiratory Questionnaire (SGRQ) scores, TeleGr was found to have worse quality of life [Table 2].

Modified MRC ($P = 0.035$), TUG ($P = 0.005$), 5-times sit-up time ($P = 0.039$), and SGRQ activity ($P = 0.003$), impact ($P = 0.005$), and total scores ($P = 0.002$) significantly improved in TeleGr at the end of the rehabilitation program. There was only an improvement in the pain score of the CGr ($P = 0.039$). SGRQ activity ($P = 0.035$) and total scores ($P = 0.042$) further improved in TeleGr

Table 1: Demographic features, hospital admission symptoms, and dropout reasons of the groups

	Telerehabilitation Control group		<i>P</i>
	group		
Demographic features			
Male/female, <i>n</i> (%)	14/3 (82/18)	11/6 (65/35)	0.251
Age (year)	50.76 (32–82)	43.24 (23–71)	0.147
BMI (kg/m²)	27.98 (21–36)	27.43 (19–36)	0.877
Smoking statues, <i>n</i> (%)			
Yes	7 (41)	4 (24)	0.279
No	10 (59)	13 (76)	
Hospital admission symptom, <i>n</i> (%)			
Symptom onset	6.23 (2–10)	5.58 (2–10)	0.524
Cough	10 (59)	11 (65)	0.728
Secretion	1 (6)	4 (24)	0.152
Fever	12 (71)	7 (41)	0.089
Weakness	11 (65)	11 (65)	1.000
GIS symptoms	7 (41)	7 (41)	1.000
Myalgia	6 (35)	5 (29)	0.718
D-dimer	1.25 (0–11)	1.22 (0–8)	0.285
ICU needs, <i>n</i> (%)	1 (6)	2 (12)	0.551
NIMV needs, <i>n</i> (%)	1 (6)	2 (12)	0.551
Patients with dropout and their causes, <i>n</i>			
Internet problem	1	0	
The hospitalization	1	0	
No response to the phone	1	2	
Not wanting to fill in the questionnaire	0	1	
Total	3	3	

BMI=Body mass index, ICU=Intensive care unit, NIMV=Noninvasive mechanic ventilation, GIS=Gastrointestinal symptoms, D'dimer=D-dimer is a biomarker of fibrin formation and degradation that can be measured in whole blood or in plasma. Healthy individuals have low levels of circulating D-dimer, whereas elevated levels are found in conditions associated with thrombosis

Table 2: Baseline features of the groups

	Median (minimum–maximum)		P
	Telerehabilitation group	Control group	
mMRC (0–4)	1 (0–2)	0 (0–2)	0.066
Symptomatic status (VAS, cm)			
Pain	3.65 (0–9)	2.88 (0–8)	0.420
Fatigue	2.05 (0–5)	1.58 (0–5)	0.503
TUG (sc)	13.12 (6–18)	11.82 (7–19)	0.259
SPPB			
Sit 5 times	3 (0–4)	3 (1–4)	0.412
8 steps walking	2 (1–4)	2 (1–4)	0.682
Side-by-side stands	1 (1–1)	1 (0–1)	0.317
Semi-tandem stand	1 (1–1)	1 (0–1)	0.317
Full-tandem stand	2 (2–2)	2 (2–2)	1.000
Total score	10.12 (5–14)	11.06 (7–15)	0.150
SGRQ			
Symptom	43.94 (4–88)	31.60 (7–53)	0.058
Activity	38.00 (0–93)	15.79 (0–66)	0.020
Impact	27.70 (5–81)	14.76 (0–67)	0.032
Total	31.47 (5–87)	16.88 (0–63)	0.033
BDI	9.11 (0–33)	4.52 (0–25)	0.078

BDI=Beck Depression Inventory, mMRC=modified Medical Research Council, SGRQ=Saint George Respiratory Questionnaire, SPPB=Short physical performance battery, TUG=Timed Up and Go Test, VAS=Visual analog scale

compared to CGr, according to the comparison of the delta values. During the study, none of the subjects experienced any complications or harmful clinical problems [Table 3].

Discussion

Results of this study showed that the telerehabilitation exercise program performed without requiring any special equipment using live videoconferencing led to improved symptom scores, increased physical performance, and improved quality of life of post-COVID-19 patients. Considering the absence of any harmful effects of the program, it can be said that the telerehabilitation exercise program is safe and useful.

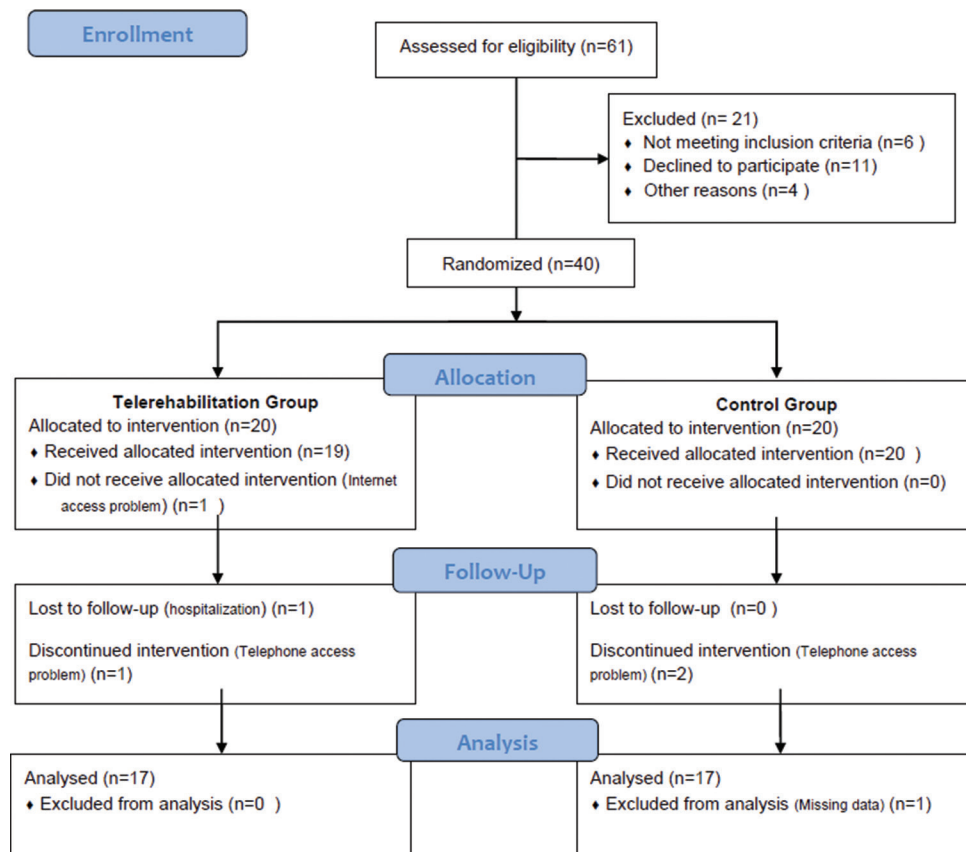
In the management of COVID-19 patients, physiotherapy applications vary in the acute and chronic periods according to the patient profile.^[18] In the chronic period, exercise programs should be implemented to reduce fatigue symptoms and physical condition losses associated with the ongoing disease.^[19] However, there is no guide on the content of the postdischarge exercise program for COVID-19 cases. In our literature review, we identified a small number of studies with post-COVID-19 rehabilitation and in the aforementioned studies, all of the evaluations were carried out in the hospital environment.^[20] Some of them were using the telerehabilitation method. In our study, the entire exercise program, including the study outcome measurements, was carried out by teleconference method. Our study is important in determining the usability of the method in disease situations with transmission risk.

There are many patient groups that receive telerehabilitation exercise programs.^[21–23] These include respiratory patients.^[24,25] In a randomized controlled study conducted on patients with chronic obstructive pulmonary disease (COPD), subjects were given upper and lower extremity range of motion exercises, aerobic and strengthening exercises such as walking and squats for 12 weeks.^[10] In another multicenter study involving 105 COPD patients, a 45-min bicycle ergometer training was performed.^[26] In a study involving 23 COPD patients who underwent home-based online pulmonary rehabilitation (PR), the program included inspiratory muscle training, exercise training, and relaxation.^[27] In the aforementioned studies, it was emphasized that telerehabilitation is effective and convenient. In our study, breathing exercises, range of motion exercises, active cycle of breathing technique, and an aerobic training were performed on the subjects by live videoconferencing with smartphone. No exercise ergometer was used in our study. Our study sets an example for the implementation of low-budget and tool-free exercise

Table 3: Comparison of outcome parameters of the groups after rehabilitation

	Telerehabilitation group				Control group				Differences between groups <i>P</i>
	Before, median (minimum–maximum)	After, median (minimum–maximum)	In group change, median (minimum–maximum)	<i>P</i>	Before, median (minimum–maximum)	After, median (minimum–maximum)	In group change, median (minimum–maximum)	<i>P</i>	
mMRC	1 (0–2)	0 (0–2)	0 (–1–2)	0.035	0 (0–2)	0 (0–1)	0 (0–1)	0.083	0.231
Symptomatic status (VAS)									
Pain	3.65 (0–9)	2.47 (0–8)	0.17 (–8–7)	0.959	2.88 (0–8)	1.76 (0–7)	1.11 (–5–5)	0.039	0.372
Fatigue	2.05 (0–5)	1.29 (0–3)	0.76 (–3–5)	0.119	1.58 (0–5)	1.47 (0–5)	0.11 (–1–3)	0.782	0.123
TUG (sc)	11.94 (8–21)	11.82 (7–19)	–1.11 (–4–1)	0.005	13.12 (6–18)	13.59 (7–19)	–0.47 (–5–6)	0.200	0.349
SPPB									
Sit 5 times	3 (0–4)	3 (2–4)	–0.64 (–4–1)	0.039	3 (1–4)	3 (1–4)	0.05 (–1–2)	0.317	0.221
8 steps walking	2 (1–4)	2 (1–4)	0.17 (–2–2)	0.559	2 (1–4)	2 (1–4)	1.41 (1–3)	0.755	0.445
Side-by-side stands	1 (1–1)	1 (1–1)	0 (0–0)	1.000	1 (0–1)	1 (1–1)	–0.05 (–1–0)	0.317	0.317
Semi-tandem stand	1 (1–1)	1 (1–1)	0 (0–0)	1.000	1 (0–1)	1 (1–1)	–0.05 (–1–0)	0.317	0.317
Full-tandem stand	2 (2–2)	2 (2–10)	–0.47 (–8–0)	0.317	2 (2–2)	2 (2–2)	0 (0–0)	1.000	0.317
Total score	10.12 (5–14)	10.59 (8–14)	–0.47 (–4–2)	0.221	11.06 (5–15)	11.00 (7–15)	0.05 (–4–4)	0.873	0.493
SGRQ									
Symptom	43.94 (4–88)	37.89 (7–58)	–1799.56	0.227	13.27	33.81 (7–54)	–1173.81	0.432	0.174
Activity	38.00 (0–93)	16.25 (0–100)	21.74	0.003	19.91	9.80 (0–53)	5.98	0.192	0.035
Impact	27.70 (5–81)	14.47 (2–78)	13.23	0.005	16.88	8.82 (0–20)	5.94	0.116	0.076
Total	31.47 (5–87)	17.70 (4–78)	13.76	0.002	15.79	11.64 (0–29)	5.23	0.139	0.042
BDI	9.11 (0–33)	5.88 (0–41)	3.23 (–8–20)	0.125	4.52 (0–25)	4.06 (0–31)	0.47 (–21–19)	0.623	0.510

BDI=Beck Depression Inventory, mMRC=modified Medical Research Council, SGRQ=Saint George Respiratory Questionnaire, SPPB=Short Physical Performance Battery, TUG: Timed Up and Go Test, VAS: Visual analog scale

**Figure 1: Study flowchart**

at home and its effectiveness. No unexpected side effects were reported in any case.

In patients with respiratory diseases, dyspnea is one of the symptoms most patients complain about. In a study comparing telerehabilitation and standard PR groups, 60 min of strength exercise and 40 min of cycling training were applied to COPD patients during 28 sessions. It was determined that the physical activity level of the TeleGr increased. No difference was found between groups in 6MWT, SGRQ, and MRC dyspnea levels.^[28] In a study conducted on asthma patients, one group was given a DVD and printed booklet, and the other group was interviewed only face to face. At the end of the study, it was reported that respiratory retraining increased the quality of life in patients with incomplete asthma.^[29] In a telerehabilitation study in older adults with COPD and heart failure disease, a total of 112 cases were randomized into two groups, and positive improvements in MRC and quality of life were detected at the end of the 4-month program in the study group.^[30] In the current study, it was found that the dyspnea level of TeleGr decreased and the dyspnea level of the CGr did not change. However, there was no statistical difference between the two groups. This situation may be caused by the fact that patients did not have severe dyspnea issues.

COVID-19 patients can also be symptomatic after discharge. One of the main goals of rehabilitation programs is symptomatic recovery. In a randomized controlled study, 60 of 116 stable male COPD patients received PR. At the end of 60 days, less desaturation, less dyspnea, and fatigue were found in the study group than the CGr.^[31] In another study conducted with 26 moderate-to-very severe COPD patients, there was a positive improvement in dyspnea and fatigue status at the end of the 8-week telerehabilitation exercise program.^[32] In this study, the baseline pain and fatigue severity were similar in the two groups. Furthermore, both groups showed similar symptomatic improvement at the end of the program. This shows that rehabilitation programs received by videoconferencing and by giving brochures provide similar gains in terms of symptom relief.

The COVID-19 patients experience decreases in exercise capacity. In a systematic review, it was concluded that the exercise program reduced the risk of frailty, sarcopenia, cognitive loss, and depressive symptoms in individuals who are isolated due to COVID-19.^[33] Therefore, exercise is indispensable in preventing or improving the negative effects associated with the pandemic. In our study, most of the standard physiotherapy outcome measurements could not be used. This is because of the impossibility of having face-to-face contact with the patients due to lockdown

measures. In our study, TUG test and SPPB were used to determine the change in the physical performance of patients. Considering telerehabilitation studies, TUG is commonly used.^[34-36] There are publications stating that the use of the SPPB in the respiratory patient group is feasible.^[37,38] In a study examining SPPB scores in different COPD phenotypes, the authors reported that SPPB should not be considered as a test to discriminate between patients with COPD with a low or preserved physical capacity and emotional status.^[39] In our study, 5-times sit-to-stand time, which is one of the SPPB subscores, was found to be reduced in TeleGr. Despite symptomatic improvement and positive developments in TUG, no significant difference in SPPB can be interpreted, as the battery is not suitable for this case group or not suitable for telerehabilitation studies.

Improvement in quality of life is one of the primary targets in all rehabilitation studies. In a randomized controlled study, telerehabilitation was reported to be feasible and well accepted by patients in the comparison of telerehabilitation and standard PR, although sometimes technology was perceived as difficult to use. In the aforementioned study, the bicycle ergometer study, stretching/relaxation and strengthening exercises were applied to patients for 28 sessions. An improvement was detected in SGRQ scores of the study group.^[28] In a study examining the effectiveness of home-based online exercise program for COPD groups, improvement in SGRQ total score was found.^[40] In our study, there was an improvement in SGRQ activity, impact, and total scores in TeleGr. However, there is no improvement observed in the CGr. As a result, the telerehabilitation exercise program improves the quality of life of COVID-19 cases and is an alternative method that should be used in pandemic situations.

The risk of depression and anxiety is also increased in patients in isolation.^[41] In a cross-sectional study, it was reported that depression and anxiety symptoms were less common in 937 isolation participants who did 30 min/day of moderate-intensity physical activity or 15 min/day of vigorous physical activity per week.^[42] In a randomized controlled study, an increase in respiratory functions and exercise capacity was detected after 6 weeks of respiratory rehabilitation applied to elderly patients with COVID-19, but it had little effect on depression.^[43] In our study, no significant difference was found in depression levels. The fact that the depression levels of the subjects were very low even at the beginning of the study prevented a statistical difference at the end of the study. This may be due to the fact that the patients have not been in intensive care for a long time and do not describe very severe symptoms. A severe disease course, especially need for invasive mechanical ventilation, can potentially adversely affect the psychology of patients.

None of our patients needed invasive mechanical ventilation.

Limitations of the study

The first is Internet problems and difficulties in using technical devices. The second limitation is that it has not been compared with the comprehensive telerehabilitation program delivered with more equipment.

As a conclusion, in the current and potential future pandemic, telerehabilitation is a useful method for patients who do not have access to standard exercise programs due to isolation measures. In addition, telerehabilitation exercise program is an effective, feasible, and safe physiotherapy method.

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Conflicts of interest

There are no conflicts of interest.

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